

APPENDIX A
PRELIMINARY DRAFT(4/10/97.) - SUBJECT TO REVISION

DWR PLANNING SIMULATION MODEL
(DWRSIM) ASSUMPTIONS FOR
CALFED EXISTING CONDITIONS SCENARIO WITH 1995 WQCP DELTA
STANDARDS
1995C6F-SWRCB-469

I. New Model Features

A new DWRSIM version with the following enhancements is employed:

- A. A new SWP and CVP south-of-Delta delivery logic uses (i) runoff forecast information and uncertainty (not perfect foresight), (ii) a delivery versus carryover risk curve and (iii) a standardized rule (Water Supply Index versus Demand Index Curve) to estimate the total water available for delivery and carryover storage. The new logic updates delivery levels monthly from January 1 through May 1 as water supply parameters become more certain. Refer to Leaf and Arora (1996) for additional information on the new delivery logic.
- B. An expanded network schematic includes more details in the Delta and along the DMC and SWP-CVP Joint Reach facility.
- C. A network representation of the San Joaquin River basin was adapted from USBR's SANJASM model. The San Joaquin River basin schematic was expanded to include (i) the Tuolumne River upstream to Hetch Hetchy and Cherry/Eleanor Reservoirs, (ii) the Merced River upstream to Lake McClure, the Chowchilla and Fresno Rivers upstream to Eastman and Hensley Lakes, respectively, and (iv) the San Joaquin River upstream to Millerton Lake.
- D. Contra Costa Water District's "G" model is used to relate Delta flows and salinities. Refer to Denton (1993) for additional information on the procedure.
- E. References:

Leaf, R.T. and Arora, S.K. (1996). "Annual Delivery Decisions in the Simulation of the California State Water Project and Federal Central Valley Project using DWRSIM." Proceedings 1996 North American Water and Environment Congress, ASCE, C.T. Bathala, Ed.

Denton, R.A. (1993). "Accounting for Antecedent Conditions in Seawater Intrusion Modeling - Applications for the San Francisco Bay-Delta." Proceedings 1993 National Conference on Hydraulic Engineering, ASCE, H.W. Shen, Ed.

II. Instream Flow Requirements

- A. Trinity River minimum fish flows below Lewiston Dam are maintained at 340 TAF/year for all years, based on a May 1991 letter agreement between the USBR and the U.S. Fish and Wildlife Service.
- B. Sacramento River navigation control point (NCP) flows are maintained at 5,000 cfs in wet and above normal water years and 4,000 cfs in all other years. This criteria is relaxed to 3,500 cfs when Shasta carryover storage drops below 1.9 MAF and is further relaxed to 3,250 cfs when Shasta carryover storage drops below 1.2 MAF.
- C. Feather River fishery flows are maintained per an agreement between DWR and the Calif. Dept. of Fish & Game (August 26, 1983). In normal years these minimum flows are 1,700 cfs from October through March and 1,000 cfs from April through September. Lower minimum flows are allowed in low runoff years and when Oroville storage drops below 1.5 MAF. A maximum flow restriction of 2,500 cfs for October and November is maintained per the agreement criteria.
- D. Stanislaus River minimum fish flows below New Melones Reservoir range from 98 TAF/year up to 302 TAF/year, according to the interim agreement (dated June 1987) between the USBR and the Calif. Dept. of Fish & Game. The actual minimum fish flow for each year is based on the water supply available for that year. Additional minimum flow requirements are imposed in June through September (15.2 - 17.4 TAF per month) to maintain dissolved oxygen levels in the Stanislaus River. Channel capacity below Goodwin Dam is assumed to be 8,000 cfs. CVP contract demands above Goodwin Dam are met as a function of New Melones Reservoir storage and inflow per an April 26, 1996 letter from USBR to SWRCB.
- E. Tuolumne River minimum fishery flows below New Don Pedro Dam are maintained per an agreement between Turlock and Modesto Irrigation Districts, City of San Francisco, Dept. of Fish & Game and others (FERC Agreement 2299). Base flows range from 50 cfs to 300 cfs. Base and pulse flow volumes depend on time of the year and water year type.
- F. Instream flow requirements are maintained in accordance with CVPIA criteria (see Item III) at the following locations: below Keswick Dam on the Sacramento River, below Whiskeytown Dam on Clear Creek and below Nimbus Dam on the American River.

III. CVPIA Flow Criteria

The following CVPIA flow criteria are in accordance with an April 26, 1996 letter from USBR to SWRCB:

- A. Flow objectives between 3,250 cfs and 5,500 cfs are maintained below Keswick Dam on the Sacramento River. Flow requirements during October through April are triggered by Shasta carryover storage.
- B. Flow objectives between 52 cfs and 200 cfs are maintained below Whiskeytown Dam on Clear Creek, depending on month and year type.
- C. Flow objectives between 250 cfs and 4,500 cfs are maintained below Nimbus Dam on the American River. Flow requirements during October through February are triggered by Folsom carryover storage. Flow requirements during March through September are triggered by previous month storage plus remaining water year inflows.

IV. Trinity River Imports

Imports from Clair Engle Reservoir to Whiskeytown Reservoir (up to a 3,300 cfs maximum) are specified according to USBR criteria. Imports vary according to month and previous month Clair Engle storage.

V. Hydrology (HYD-C06F)

A new 1995 level hydrology, HYD-C06F, was developed similar to HYD-C06B described in a June 1994 memorandum report entitled "Summary of Hydrologies at the 1990, 1995, 2000, 2010 and 2020 Levels of Development for Use in DWRSIM Planning Studies" published by DWR's Division of Planning. HYD-C06B was based on DWR Bulletin 160-93 land use projections and simulates the 71 year period 1922-92. HYD-C06F, developed through consultation with USBR to address differences in San Joaquin basin hydrology, simulates two additional years (through 1994) and includes the following major modifications compared to HYD-C06B:

- A. Stand-alone HEC-3 models of the American, Yuba and Bear River subsystems were updated and extended through 1994. Yuba River minimum fishery flows below Bullards Bar Dam were not modified to reflect new FERC requirements. According to consultants for the Yuba County Water Agency, water supply impacts of the new requirements are not substantially different from those modeled in HYD-C06B.
- B. Mokelumne River minimum fishery flows below Camanche Dam are modeled in HYD-C06F per an agreement between EBMUD, U.S. Fish and Wildlife Service, and Calif. Dept. of Fish & Game (FERC Agreement 2916). Base flows range from 100 cfs to 325 cfs from October through June, depending on time of the year and water year type. Base flows are maintained at 100 cfs from July through September for all water year types. Water year types are determined by reservoir storage and unimpaired runoff. For the months of April through June, additional

pulse flows are maintained up to 200 cfs depending on water year type and reservoir storage.

- C. Historical 1993-94 land use was estimated by linear interpolation between 1990 and 2000 normalized projected levels.

VI. Pumping Plant Capacities, Coordinated Operation & Wheeling

- A. SWP Banks Pumping Plant average monthly capacity with 4 new pumps is 6,680 cfs (or 8,500 cfs in some winter months) in accordance with USACE October 31, 1981 Public Notice criteria.
- B. CVP Tracy Pumping Plant capacity is 4,600 cfs, but constraints along the Delta Mendota Canal and at the relief pumps (to O'Neil Forebay) can restrict export capacity as low as 4,200 cfs.
- C. CVP/SWP sharing of responsibility for the coordinated operation of the two projects is maintained per the Coordinated Operation Agreement. Storage withdrawals for in-basin use are split 75 percent CVP and 25 percent SWP. Unstored flows for storage and export are split 55 percent CVP and 45 percent SWP.
- D. Wheeling of CVP water through SWP facilities to San Luis Reservoir is permitted as needed to offset the CVP Tracy Pumping Plant's compliance with D-1485 criteria in May and June. SWP pumping capacity is made available so that CVP wheeling is completed in July and August of each year.
- E. CVP water is not wheeled to meet Cross Valley Canal demands.
- F. Enlarged East Branch aqueduct capacities are assumed from Alamo Powerplant to Devil Canyon Powerplant.

VII. Target Reservoir Storage

- A. Shasta Reservoir carryover storage is maintained at or above 1.9 MAF in all normal water years for winter-run salmon protection per the NMFS biological opinion. However, in critical years following critical years, storage is allowed to fall below 1.9 MAF to 1.2 MAF (and lower in extremely dry years).
- B. Folsom Reservoir storage capacity was reduced from 1010 TAF down to 975 TAF due to sediment accumulation as calculated from a 1992 reservoir capacity survey.
- C. Folsom flood control criteria are in accordance with the December 1993 USACE report "Folsom Dam And Lake Operation Evaluation". This criteria uses

available storage in upstream reservoirs such that the maximum flood control reservation varies from 400 TAF to 670 TAF.

VIII. SWP Demands, Deliveries & Deficiencies

- A. Deficiencies are imposed as needed per Monterey Agreement criteria and are calculated from the following 1996 Table A entitlements assuming zero entitlements and deliveries to Santa Barbara and San Luis Obispo Counties through the Coastal Aqueduct:

Agricultural Entitlements	1,175 TAF/year
M & I Entitlements	2,869 TAF/year
Recreation & Losses	64 TAF/year
Total Entitlements	4,108 TAF/year

- B. Maximum SWP Contractor deliveries are designed to vary in response to local wetness indexes. As such, maximum deliveries are reduced in the wetter years, assuming greater availability of local water supplies.

1. Deliveries to San Joaquin Valley agricultural contractors are reduced in wetter years using the following index developed from annual Kern River inflows to Lake Isabella:

	Dry/Avg.	Above	Wet
Kern River flow (TAF/year)	<1,000	1,000-1,400	>1,400
Max. Ag delivery (TAF)	1,175	1,100	915

2. Deliveries to Metropolitan Water District of Southern California are reduced in wetter years using the 10-station, two-year average precipitation index:

	Dry	Avg.	Above	Wet
S. Calif. Precipitation (in/yr)	<15	15-17.9	18-20.9	>20.9
Max. MWDSC delivery (TAF)	1,433	1,183	883	783

3. Maximum deliveries to all other SWP M&I Contractors are NOT adjusted for a wetness index, and are set at 857 TAF/year in all years. As a result of the use of these wetness indexes, the total maximum delivery to all SWP Contractors varies by year, ranging between 3,529 TAF in the dry-average years down to 2,619 TAF in the wetter years, as follows:

	Dry/Avg.	Avg.	Above	Wet
Max. Ag delivery	1,175	1,175	1,100	915
Max. MWDSC delivery	1,433	1,183	883	783
Max. Other M&I delivery	857	857	857	857
Fixed Losses & Recreation	64	64	64	64

Total Maximum SWP Deliver 3,529 (total varies) 2,619

A range of maximum SWP deliveries is possible as the two wetness indexes are independent of each other. Thus a given year may be classified as "average" for agricultural deliveries by the Kern River flow index, and at the same time be classified as "above average" or "wet" for MWDSC deliveries by the Southern California precipitation index.

- C. When available, "interruptible" water is delivered to SWP south-of-Delta contractors in accordance with the following assumptions based on the Monterey Amendment White Paper redraft dated September 28, 1995:
1. Interruptible water results from direct diversions from Banks Pumping Plant. It is not stored in San Luis Reservoir for later delivery to contractors.
 2. A contractor may accept interruptible water in addition to its monthly scheduled entitlement water. Therefore, the contractor may receive water above its Table A amount for the year. Interruptible water deliveries do not impact entitlement water allocations.
 3. If demand for interruptible water is greater than supply in any month, the supply is allocated in proportion to the Table A entitlements of those contractors requesting interruptible water. The maximum demand assumed for interruptible water is 84 TAF per month.

IX. CVP Demands, Deliveries & Deficiencies

- A. 1995 level CVP demands, including canal losses but excluding wildlife refuges are assumed as follows (see Item IXB below for refuge demands):

Contra Costa Canal	=	140 TAF/year
DMC and Exchange	=	1,561
CVP San Luis Unit	=	1,260
San Felipe Unit	=	196
Cross Valley Canal	=	128
Total CVP Delta Exports	=	3,285 TAF/year

Including wildlife refuges, total CVP demand is 3,573 TAF/year. CVP Delta export demands are reduced in certain wet years (in the San Joaquin River Basin) when "James" bypass flows are available in the Mendota Pool.

- B. Sacramento Valley refuge demands, Level II and 30% of the difference between Level IV-Level II) are modeled implicitly in the hydrology through rice field and duck club operations. Sacramento Valley refuges include Gray Lodge, Modoc,

Sacramento, Delevan, Colusa and Sutter. Level II refuge demands in the San Joaquin Valley are explicitly modeled at an assumed level of 288 TAF/year. San Joaquin refuges include Grasslands, Volta, Los Banos, Kesterson, San Luis, Mendota, Pixley, Kern and those included in the San Joaquin Basin Action Plan.

- C. CVP South-of-Delta deficiencies are imposed when needed by contract priority. Contracts are classified into four groups: agricultural (Ag), municipal and industrial (M&I), Exchange and Refuge. Deficiencies are imposed in accordance with the Shasta Index and sequentially according to the following rules:
1. Ag requests are reduced up to a maximum of 50 percent.
 2. Ag, M&I and Exchange requests are reduced by equal percentages up to a maximum of 25 percent. At this point, cumulative Ag deficiencies are 75 percent.
 3. Ag, M&I and Refuge requests are reduced by equal percentages up to a maximum of 25 percent. At this point, cumulative Ag and M&I deficiencies are 100 percent and 50 percent, respectively.
 4. M&I requests are reduced until cumulative deficiencies are 100 percent.
 5. Further reductions are imposed equally upon Exchange and Refuge.
- D. Deficiencies in the form of "dedicated" water and "acquired" water to meet 800 TAF/year CVPIA demands are not imposed.

X. Delta Standards

In the following assumptions related to Delta standards, reference is made to the SWRCB's May 1995 Water Quality Control Plan (Plan):

- A. Water Year Classifications
1. The Sacramento Valley 40-30-30 Index (as defined on page 23 of the Plan) is used to determine year types for Delta outflow criteria and Sacramento River system requirements unless otherwise specified in the Plan.
 2. The San Joaquin Valley 60-20-20 Index (page 24) is used to determine year types for flow requirements at Vernalis.
 3. The Sacramento River Index, or SRI (Footnote 6, page 20), is used to trigger relaxation criteria related to May-June Net Delta Outflow Index (NDOI) and salinity in the San Joaquin River and western Suisun Marsh.

4. The Eight River Index (Footnote 13, page 20) is used to trigger criteria related to (i) January NDOI, (ii) February-June X2 standards and (iii) February export ratio.

B. M&I Water Quality Objectives (Table 1, page 16)

1. The water quality objective at Contra Costa Canal intake is maintained in accordance with the Plan. A "buffer" was added to insure that the standard is maintained on a daily basis. Thus, DWRSIM uses a value of 130 mg/L for the 150 mg/L standard and a value of 225 mg/L for the 250 mg/L standard.
2. The M&I water quality objectives at Clifton Court Forebay, Tracy Pumping Plant, Barker Slough and Cache Slough are not modeled.

C. Agricultural Water Quality Objectives (Table 2, page 17)

1. Water quality objectives on the Sacramento River at Emmaton and on the San Joaquin River at Jersey Point are maintained in accordance with the Plan.
2. Plan water quality objectives on the San Joaquin River at Vernalis are 0.7 EC in April through August and 1.0 EC in other months. These objectives are maintained primarily by releasing water from New Melones Reservoir. A cap on water quality releases is imposed per criteria outlined in an April 26, 1996 letter from USBR to SWRCB. The cap varies between 70 TAF/year and 200 TAF/year, depending on New Melones storage and projected inflow.
3. The interior Delta standards on the Mokelumne River (at Terminous) and on the San Joaquin River (at San Andreas Landing) are not modeled.
4. The export area 1.0 EC standards at Clifton Court Forebay and Tracy Pumping Plant are not modeled.

D. Fish & Wildlife Water Quality Objectives: Salinity (Table 3, page 18)

1. The 0.44 EC standard is maintained at Jersey Point in April and May of all but critical years. Per Footnote 6 (page 20), this criteria is dropped in May if the projected SRI is less than 8.1 MAF. The salinity requirement at Prisoners Point is not modeled.
2. The following EC standards are maintained at Collinsville for eastern Suisun Marsh salinity control:

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
EC-Ave. High Tide	19.0	15.5	15.5	12.5	8.0	8.0	11.0	11.0

The corresponding EC standards for other locations in the eastern and western Suisun Marsh are not modeled.

E. Fish & Wildlife Water Quality Objectives: Delta Outflow (Table 3, page 19)

1. Minimum required NDOI (cfs) is maintained as follows:

Year Type	Oct	Nov	Dec	Jan	Feb-Jun	Jul	Aug	Sep
Wet	4000	4500	4500 *	**		8000	4000	3000
Above Normal	4000	4500	4500 *	**		8000	4000	3000
Below Normal	4000	4500	4500 *	**		6500	4000	3000
Dry	4000	4500	4500 *	**		5000	3500	3000
Critical	3000	3500	3500 *	**		4000	3000	3000

* January: Maintain either 4,500 cfs or 6,000 cfs if the December Eight River Index was greater than 800 TAF (per Footnote 13 page 20).

** February-June: Maintain 2.64 EC standards (X2) as described below.

2. For February through June, outflow requirements are maintained in accordance with the 2.64 EC criteria (also known as X2) using the required number of days at Chipps Island (74 km) and Roe Island (64 km). See Footnote 14 for Table 3 (Table A) page 26.

- a) At the Confluence (81 km), the full 150 days (February 1 - June 30) of 2.64 EC is maintained in all years, up to a maximum required flow of 7,100 cfs. This requirement is dropped in May and June of any year for which the projected SRI is less than 8.1 MAF. In those years when the criteria is dropped, a minimum outflow of 4,000 cfs is maintained in May and June.
- b) The criteria -- "If salinity/flow objectives are met for a greater number of days than the requirements for any month, the excess days shall be applied to meeting the requirements for the following month" -- is not modeled. See Footnote "a" of Footnote 14 for Table 3 (Table A).
- c) The Kimmerer-Monismith monthly equation is used to calculate outflow required (in cfs) to maintain the EC standard (average

monthly position in kilometers). In this equation the EC position is given and Delta outflow is solved for.

$$\text{EC position} = 122.2 + [0.3278 * (\text{previous month EC position in km}) - [17.65 * \log_{10}(\text{current month Delta outflow in cfs})]$$

In months when the EC standard is specified in more than one location (e.g. 19 days at the confluence and 12 days at Chipps Island), required outflow for the month is computed as a flow weighted average of the partial month standards.

3. Additional details on the 2.64 EC criteria are modeled as follows:
 - a) The trigger to activate the Roe Island standard is set at 66.3 km from the previous month, as an average monthly value.
 - b) The maximum required monthly outflows to meet the 2.64 EC standard are capped at the following limits: 29,200 cfs for Roe Island; 11,400 cfs for Chipps Island; and 7,100 cfs for the Confluence.
 - c) Relaxation criteria for the February Chipps Island standard is a function of the January Eight River Index as follows:
 - 1) X2 days = 0 if the Index is less than 0.8 MAF
 - 2) X2 days = 28 if the Index is greater than 1.0 MAF
 - 3) X2 days vary linearly between 0 and 28 if the Index is between 0.8 MAF and 1.0 MAF

F. Fish & Wildlife Water Quality Objectives: River Flows (Table 3, page 19)

1. Minimum Sacramento River flow requirements (cfs) at Rio Vista are maintained as follows:

Year Type	Sep	Oct	Nov	Dec
Wet	3,000	4,000	4,500	4,500
Above Normal	3,000	4,000	4,500	4,500
Below Normal	3,000	4,000	4,500	4,500
Dry	3,000	4,000	4,500	4,500
Critical	3,000	3,000	3,500	3,500

2. From February 1 through June 30, minimum flows on the San Joaquin River at Vernalis are maintained per the table below. For each period, the higher flow is required whenever the 2.64 EC Delta outflow position is located downstream of Chipps Island (<74 km). If the 2.64 EC Delta

outflow position is upstream of Chipps Island (>74 km), then the lower flow requirement is used.

Minimum Flows at Vernalis (cfs)		
Feb1-Apr14 &		
Year Type	May16-June30	April15-May15
Wet	2,130 or 3,420	7,330 or 8,620
Above Normal	2,130 or 3,420	5,730 or 7,020
Below Normal	1,420 or 2,280	4,620 or 5,480
Dry	1,420 or 2,280	4,020 or 4,880
Critical	710 or 1,140	3,110 or 3,540

3. For the month of October, the minimum flow requirement at Vernalis is 1,000 cfs in all years PLUS a 28 TAF pulse flow (per Footnote 19, page 21). The 28 TAF pulse (equivalent to 455 cfs monthly) is added to the actual Vernalis flow, up to a maximum of 2,000 cfs. The pulse flow requirement is not imposed in a critical year following a critical year. These two components are combined as an average monthly requirement as follows:

October Minimum Flows at Vernalis(cfs)	
Base Flow	Required Flow
<1000	1455
1000-1545	Base Flow+455
>1545	2000

4. The above flow requirements at Vernalis are maintained primarily by releasing additional water from New Melones Reservoir. In years when New Melones Reservoir drops to a minimum storage of 80 TAF (per April 26, 1996 letter from USBR to SWRCB), additional water is provided equally from the Tuolumne and Merced River systems to meet the Vernalis flow requirements. If these sources are insufficient to meet objectives at Vernalis, nominal deficiencies will be applied to upstream demands.

G. Fish & Wildlife Water Quality Objectives: Export Limits (Table 3, page 19)

1. Ratios for maximum allowable Delta exports are specified as a percentage of total Delta inflow as follows:

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
65	65	65	65	35- 45	35	35	35	35	65	65	65

- a) In February the export ratio is a function of the January Eight River Index per Footnote 25, page 22 as follows:
 - i) 45% if the Jan. 8-River Index is less than 1.0 MAF
 - ii) 35% if the Jan. 8-River Index is greater than 1.5 MAF
 - iii) Varies linearly between 45% and 35% if the January Eight River Index is between 1.0 MAF and 1.5 MAF.
 - b) For this ratio criteria, total Delta exports are defined as the sum of pumping at the SWP Banks and CVP Tracy Pumping Plants. Total Delta inflow is calculated as the sum of river flows from the Sacramento River, Yolo Bypass, total from the Eastside stream group, and San Joaquin River inflow. Delta area precipitation and consumptive uses are not used in this ratio.
2. Based on Footnote 22 page 21, April and May total Delta export limitations are modeled as follows:
- a) April 15 - May 15 exports are limited to 1,500 cfs OR 100 percent of the San Joaquin River flow at Vernalis, whichever is greater.
 - b) April 1-14 and May 16-31 export limits are controlled by either the export/inflow ratio (35%) or pumping plant capacity, whichever is smaller.
- H. Fish & Wildlife Water Quality Objectives: Delta Cross Channel (Table 3, page 19)
- 1. The Delta Cross Channel (DCC) is closed 10 days in November, 15 days in December and 20 days in January for a total closure of 45 days per Footnote 26, page 22.
 - 2. The DCC is fully closed from February 1 through May 20 of all years and is closed an additional 14 days between May 21 and June 15 per Footnote 27, page 22.